Apr 28th, 12:00 AM - 12:00 AM

Examination of Wastewater for Microplastics

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Introduction

Microplastics are being found everywhere. There are microplastics being found on the sea surface, in freshwater streams, in sediment, fertilizer in agriculture fields, rain, snow, and ice in the Arctic. There are also studies of microplastics being found in fish digestive systems, human organs, and contamination of tap water and beer. Some of these studies are the first in their field, but already positive results have shown microplastics being found.

Another place microplastics have been found is in wastewater treatment plants (WWTP). A previous study on WWTPs from the Susquehanna River Valley was conducted in 2019 (figure 1), found microplastics in the effluent which flows into the river. The location for this study is at the Eastern Snyder County Water Authority in Selinsgrove, Pennsylvania. This study is focused on examining the influent and effluent sources to identify the abundance and size of microplastics within the wastewater. It was expected that the influent would contain a greater amount and size of microplastics than the effluent.

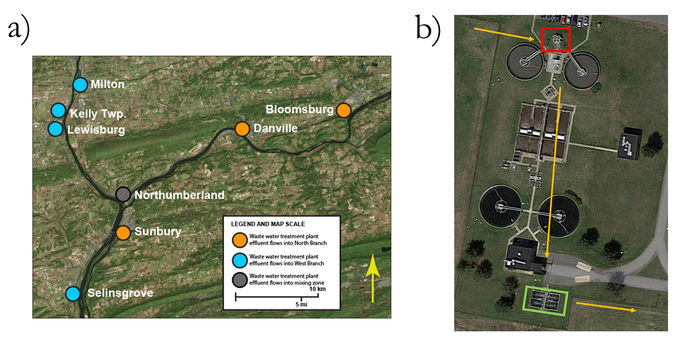

Figure 1: a) Map showing locations of wastewater treatment plants from North and West branches of the Susquehanna River, from (Elick et al., 2019). b) Eastern Snyder County Water Authority aerial view. The red box indicates where influent samples were collected, and effluent sample collection is indicated by the green box. Yellow arrows indicate the general direction of water flow.

Methods

1L bottles of influent and effluent were collected from the Eastern Snyder County Water Authority. The filtering and chemical digestion processes were modified using criteria described in Rodrigues et al. (2016).

Influent samples went through a chemical digestion activated by heat to remove organic materials, then filtered using a vacuum-pressure system, air dried overnight in an enclosed room, and stored in glass petri dishes. Effluent samples were filtered with a vacuum-pressure system, dried with heat and stored in glass petri dishes. Microplastic classification was determined using a soldering iron and hot needle point, and if the microplastic reacted to the heat (figure 2).

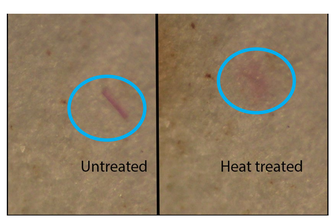

Figure 2: Before and after heat treatment photos of microplastic particle (fragment).

Microplastics

Many different kinds of microplastic shapes and densities have been characterized from water samples (figure 3). Plastics in wastewater may be derived from different primary sources: cosmetics, personal hygiene products, and cleaning products, fibers from laundry/wash etc. Additional secondary sources of plastic may be derived from physical break down of larger plastic pieces. In this study, microplastics are considered less than 5 mm long- they can be any color and shape.

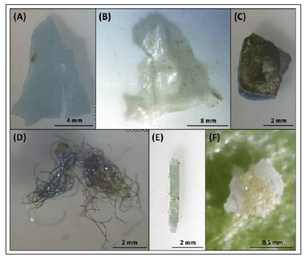

Figure 3: Examples of microplastic shapes that have been found in various environments: (A) Fragment, (B) Film, (C) Foam, (D) Fiber, (E) Line, (F) Pellet (from Free et al., 2014)

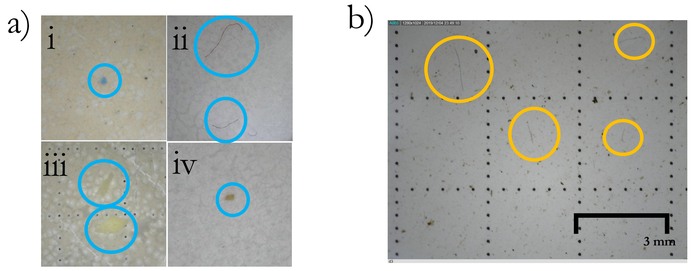

Figure 4: a) Examples of microplastics identified in influent samples: i) microplastic pellet, ii) films, iii) 2 fragments, and iv) a smaller colored fragment. b) Examples of microplastics identified in the effluent. Only microfibers were found in the effluent.

Results

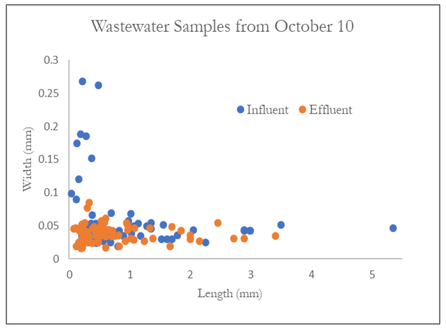

Figure 5: Microplastics from influent (I) and effluent (E) samples collected October 10, 2019. This graph represents microplastics from both water samples (IN = 72, EN = 71). The samples contained film and pellet shapes. October 10 samples had 7 examples of film and pellet shapes, the other microplastics were characterized as fibers. The effluent only contained microplastic fibers.

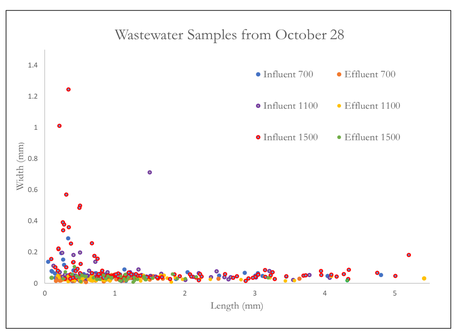

Figure 6: Microplastics from influent (I) and effluent (E) samples collected October 28, 2019, over a 24-hour period. This graph represents microplastics from three water samples, from 7 am (IN= 70, EN= 134), 11 am (IN= 81, EN= 64), and 3 pm (IN= 110, EN= 42). The samples contained fragment, film, line, and pellet shapes. The effluent only contained microplastic fibers

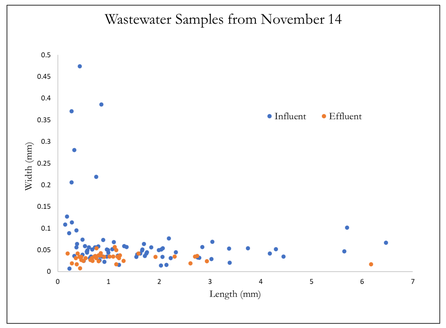

Figure 7: Microplastics from influent (I) and effluent (E) samples collected November 14, 2019. This graph represents microplastics from both water samples (IN = 80, EN = 41). The samples contained film and pellet shapes. November 14 samples had 9 examples of film, line, and pellet shapes, the other microplastics were characterized as fibers. The effluent only contained microplastic fibers.

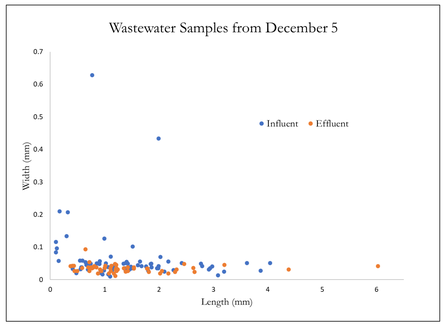

Figure 8: Microplastics from influent (I) and effluent (E) samples collected December 5, 2019. This graph represents microplastics from both water samples (IN = 80, EN = 54). The samples contained film and fragment shapes. December 5 samples had 4 examples of film and fragment shapes, the other microplastics were characterized as fibers. The effluent only contained microplastic fibers.

Conclusion

There are more microplastics than previously thought within wastewater. There are more microplastics in the effluent than the influent. Larger microplastics are being found within the influent, however the filtration system filters out the coarser grains (films, fragments, and pellet shapes) before the water reaches the effluent. Microplastic fibers are not settling or filtering from the wastewater. They flow directly into the local river. Microplastics are being found in many organisms and may move through the highest levels of the food chain. Unless new designs for microplastic removal from WWTP are developed, there is a potential for this environmental problem to continue.

Future studies should include examination of microplastics in the organic brick, or "cake", and looking at the influent of the WWTPs along the Susquehanna River.

Acknowledgements

- The Eastern Synder County Water Authority for allowing the collection of water samples every week
- Dr. Derek Straub for the use of a cooler for storing samples
- Dr. Jon Niles and Timothy Parks for combining information of chemical digestion